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Part 3: Rock mechanics

Exploitation minière — Vocabulaire —

Partie 3: Mécanique des roches

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Foreword

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This document was prepared by Technical Committee ISO/TC 82, *Mining*.

A list of all parts in the ISO 22932 series can be found on the ISO website.

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Introduction

The ISO 22932 series has been prepared in order to standardize and to coordinate the global use of technical terms and definitions in mining, for the benefit of the experts working on different types of mining activities.

The need for the ISO 22932 series arose from the widely varying interpretation of terms used within the industry and the prevalent use of more than one synonym.

Mining – Vocabulary —

Part 3:
Rock mechanics

1 Scope

This document specifies the rock-mechanics terms commonly used in mining. Only those terms that have a specific meaning in this field are included.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1 General terms

3.1.1
abrasion
rubbing and wearing away

[SOURCE: Reference [1], 235]

3.1.2
angle of repose
maximum angle with respect to the horizontal plane that the surface of a pile of a loose material will assume

[SOURCE: Reference [1], 3]

3.1.3
erosion
process whereby soil or *rock mass* (3.5.25) is loosened or dissolved and removed from any part of the earth's surface

Note 1 to entry: It includes *weathering* (3.1.8), solution and transportation.

[SOURCE: IS 11358:1987, 2.109, modified — Note 1 to entry was originally part of the definition]

3.1.4
incompetent rock
rock (3.1.5) incapable of standing in underground opening or steep slopes at the surface without support

[SOURCE: IS 11358:1987, 2.155]

3.1.5
rock
solid material forming as part of the earths' crust

3.1.6
rock material
smallest element of *rocks* (3.1.5) not cut by any *fracture* (3.6.20)

Note 1 to entry: There are always some micro-fractures in the *rocks* (3.1.5) material.

[SOURCE: IS 11358:1987, 2.253, modified — Note 1 to entry was originally part of the definition.]

3.1.7
rock mechanics
theoretical and applied science of the mechanical behaviour of *rock* (3.1.5)

[SOURCE: Reference [1], 9]

3.1.8
weathering
process of disintegration and decomposition as a consequence of exposure to the atmosphere, to chemical action, and to the action of frost, water, and heat

[SOURCE: Reference [1], 99]

3.2 Stress

3.2.1
biaxial compression
compression caused by the application of *normal stresses* (3.2.20) in two perpendicular directions

[SOURCE: Reference [1], 20]

3.2.2
biaxial state of stress
state of *stress* (3.2.29) in which one of the three principal *stresses* (3.2.29) is zero

[SOURCE: Reference [1], 33]

3.2.3
coefficient of friction
μ
relating *normal stress* (3.2.20) and the corresponding critical *shear stress* (3.2.27) at which *sliding* (3.8.36) starts between two surfaces as follows:

$$\tau = \mu \cdot \sigma$$

where

τ is the shear stress;

μ is the coefficient of friction;

σ is the normal stress.

[SOURCE: Reference [1], 1]

3.2.4
cohesion
<stress> shear resistance at zero *normal stress* (3.2.20)

Note 1 to entry: An equivalent term in *rock mechanics* (3.1.7) is intrinsic shear *strength* (3.9.31).

Note 2 to entry: Compare with *cohesion* (3.9.8).

[SOURCE: Reference [1], 72, modified — Note 1 to entry was originally part of the definition.]

3.2.5
competent ground
rock mass (3.5.25) *strength* (3.9.31) which is higher than the ground *stresses* (3.2.29) imposed

Note 1 to entry: See Reference [4].

3.2.6
compressive stress
normal stress (3.2.20) tending to shorten the body in the direction in which it acts

[SOURCE: Reference [1], 50]

3.2.7
critical stress
maximum and minimum *compressive stress* (3.2.6) on the boundary of an opening

[SOURCE: IS 11358:1987, 2.75]

3.2.8
cyclical stress
stress (3.2.29) produced by repeated stressing and de-stressing

[SOURCE: IS 11358:1987, 2.82, modified — The phrase "stress produced" has been added and "of material" was originally part of the definition.]

3.2.9
dilatancy
property of volume increase under loading

[SOURCE: Reference [1], 75]

3.2.10
effective stress
pore water pressure (3.9.20) in *rock* (3.1.5) as a factor affecting *rock* (3.1.5) *strength* (3.9.31)

Note 1 to entry: The effective *normal stress* (3.2.20) is generally taken equal to the difference between normal stress and the pore water pressure.

Note 2 to entry: This is strictly valid only where pores, *cracks* (3.6.11) and *fractures* (3.6.20) are interconnected.

[SOURCE: IS 11358:1987, 2.107, modified — Notes 1 and 2 to entry were originally part of the definition.]

3.2.11
finite element
one of the regular geometrical shapes into which a figure is subdivided for the purpose of numerical *stress* (3.2.29) analysis

[SOURCE: Reference [1], 17]

3.2.12
hydraulic fracturing
method to measure the principal *stress* (3.2.29) situation by fracturing of the *rock* (3.1.5) surrounding a section of a drill hole

Note 1 to entry: The *fracture* (3.6.20) is obtained using increasing water pressure.

Note 2 to entry: See Reference [4].

3.2.13
hydrostatic pressure
state of *stress* (3.2.29) in which all the principal *stresses* (3.2.29) are equal (and there is no *shear stress* (3.2.27)

[SOURCE: Reference [1], 48]

3.2.14
incompetent ground
overstressed *rock masses* (3.5.25)

Note 1 to entry: See Reference [4].

3.2.15
inelastic deformation
portion of *deformation* (3.8.13) under *stress* (3.2.29) that is not annulled by removal of *stress* (3.2.29)

[SOURCE: Reference [1], 67]

3.2.16
keelformed overbreak
characteristic shape of overbreak caused by high, anisotropic *rock* (3.1.5) *stress* (3.2.29)

Note 1 to entry: See Reference [4].

3.2.17
Kirsch's equation
equation, which may be used for evaluating the tangential *stresses* (3.2.29) around tunnels and other underground openings

Note 1 to entry: See Reference [4].

3.2.18
k-value
ratio between horizontal and vertical *stresses* (3.2.29) within the *rock mass* (3.5.25)

Note 1 to entry: See Reference [4].

3.2.19
Mohr’s envelope
envelope of a sequence of Mohr’s circles representing *stress* (3.2.29) conditions at *failure* (3.6.15) for a given material

[SOURCE: Reference [1], 12]

3.2.19.1
angle of internal friction
angle of shear resistance
angle, ϕ, (degrees) between the axis of *normal stress* (3.2.20) and the tangent to the *Mohr’s envelope* (3.2.19) at a point representing a given *failure* (3.6.15)-*stress* (3.2.29) condition for solid material

[SOURCE: Reference [1], 2]

3.2.20
normal stress
stress (3.2.29) in a *rock* (3.1.5) perpendicular to the *shear stress* (3.2.27)

[SOURCE: IS 11358:1987, 2.203, modified — The phrase "(normal)" was removed of the definition]

3.2.21
primary state of stress
state of *stress* (3.2.29) in a geological formation before it is disturbed by an opening

Note 1 to entry: Adapted from Reference [1], 46.

3.2.22
primitive stress
virgin rock stress
ground which is in a state of equilibrium before excavation of a tunnel or any underground opening

Note 1 to entry: At this stage, the *stresses* (3.2.29) at any point within the ground are termed as "primitive", "primary" or "pre-excavation" *stresses* (3.2.29).

[SOURCE: IS 11358:1987, 2.234, modified — Note 1 to entry was originally part of the definition.]

3.2.23
plasticity
property of a material to continue to deform indefinitely while sustaining a constant *stress* (3.2.29)

[SOURCE: Reference [1], 94]

3.2.24
relaxation
rate of reduction of *stress* (3.2.29) in a material due to *creep* (3.8.10)

Note 1 to entry: An alternate term is *stress* (3.2.29) relaxation.

[SOURCE: IS 11358:1987, 2.240, modified — Note 1 to entry was originally part of the definition.]

3.2.25
residual stress
stress (3.2.29) remaining in a solid under zero external *stress* (3.2.29) after some process that causes the dimensions of the various parts of the solid to be incompatible under zero *stress* (3.2.29)

EXAMPLE 1 *Deformation* (3.8.13) under the action of external *stress* (3.2.29) when some parts of the body suffer *permanent strain* (3.3.7).

EXAMPLE 2 Heating or cooling of a body in which the thermal expansion coefficient is not uniform throughout the body.

[SOURCE: Reference [1], 49, modified — EXAMPLES 1 and 2 to entry were originally part of the definition.]

3.2.26
secondary state of stress
resulting state of *stress* (3.2.29) in the *rock* (3.1.5) around an opening

[SOURCE: Reference [1], 47, adapted]

3.2.27
shear stress
stress (3.2.29) directed parallel to the surface element across which it acts

[SOURCE: Reference [1], 51]

3.2.28
stability
condition of a structure or a mass of material when it is able to support the applied *stress* (3.2.29) for a long time without suffering any significant *deformation* (3.8.13) or movement that is not reversed by the release of stress

[SOURCE: Reference [1], 15]

3.2.29
stress
force acting across a given surface element, divided by the area of the element as follows:

$$\sigma = \frac{F_v}{A}$$

$$\tau = \frac{F_h}{A}$$

where

σ is the *normal stress* (3.2.20);

τ is the *shear stress* (3.2.27);

F_v is the vertical force;

F_h is the horizontal force;

A is the area of element.

[SOURCE: Reference [1], 66]

3.2.30
stress concentration factor
ratio of tangential *stress* (3.2.29) at a particular point along the periphery and the initial stress before excavation at that point

Note 1 to entry: Stress concentration takes place when a cavity is excavated in a *rock mass* (3.5.25).

Note 2 to entry: The higher the stress concentration factor, the greater are the chances of *failure* (3.6.15) of the rock mass or *rock burst* (3.8.30).

[SOURCE: IS 11358:1987, 2.311, modified — Notes 1 and 2 to entry were originally part of the definition.]

3.2.31
stress ellipsoid
representation of the state of *stress* (3.2.29) in the form of an ellipsoid whose semi-axes are proportional to the magnitudes of the principal stresses and lie in the principal directions

Note 1 to entry: The coordinates of a point *P* on this ellipse are proportional to the magnitudes of the respective components of the stress across the plane normal to the direction *OP*, where *O* is the centre of the ellipsoid.

[SOURCE: Reference [1], 5, modified — Note 1 to entry was originally part of the definition.]

3.2.32
tensile stress
normal stress (3.2.20) tending to lengthen the body in the direction in which it acts

[SOURCE: Reference [1], 52]

3.2.33
thermal stress
internal *stress* (3.2.29), caused in part by uneven heating

[SOURCE: IS 11358:1987, 2.327]

3.2.34
triaxial compression
compression caused by the application of *normal stresses* (3.2.20) in three perpendicular directions

[SOURCE: Reference [1], 21]

3.2.35
triaxial state of stress
state of *stress* (3.2.29) in which none of the three principal stresses is zero

[SOURCE: Reference [1], 24]

3.2.36
uniaxial compression
unconfined compression
compression caused by the application of *normal stress* (3.2.20) in a single direction

[SOURCE: Reference [1], 19]

3.2.37
uniaxial state of stress
state of *stress* (3.2.29) in which two of the three principal stresses are zero

[SOURCE: Reference [1], 22]

3.2.38
yield stress
stress (3.2.29) beyond which the induced *deformation* (3.8.13) is not fully annulled after complete distressing

[SOURCE: Reference [1], 68]

3.3 Strain

3.3.1
brittleness
material condition characterised by reduced ability to carry load as the *strain* (3.3.11) increases

Note 1 to entry: See Reference [4].

3.3.2
contraction
linear *strain* (3.3.11) associated with a decrease in length

[SOURCE: Reference [1], 25]

3.3.3
ductility
condition in which material can sustain permanent *deformation* (3.8.13) without losing its ability to resist load, or on the other hand for a known or particular *stress* (3.2.29) state (existing or imposed) to which a material can sustain *plastic deformation* (3.8.26) without *breaking* (3.6.7) or *rupture* (3.6.30)

Note 1 to entry: Elongation and reduction of area are common indices of ductility.

